



Antenna Gain Measurement for P-band Airborne SAR Calibration Using Corner Reflectors

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Context



- UAVSAR – polarimetric calibration of the p-band Radar requires an accurate knowledge of its antenna pattern.
- Wide bandwidth UHF antenna is mounted in pod underneath the aircraft: there is EM coupling between antenna and platform structure.
- Difficulty in assessing and verifying EM simulation results for radiating antenna mounted close to the aircraft and wings, inside the antenna mounting pod.
- Estimation of antenna gain from corner reflector SAR data is required.

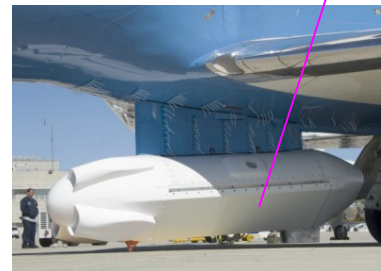
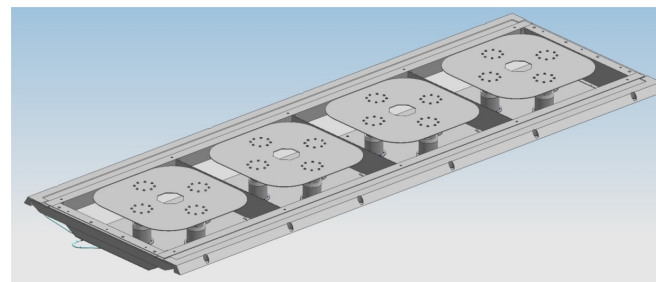


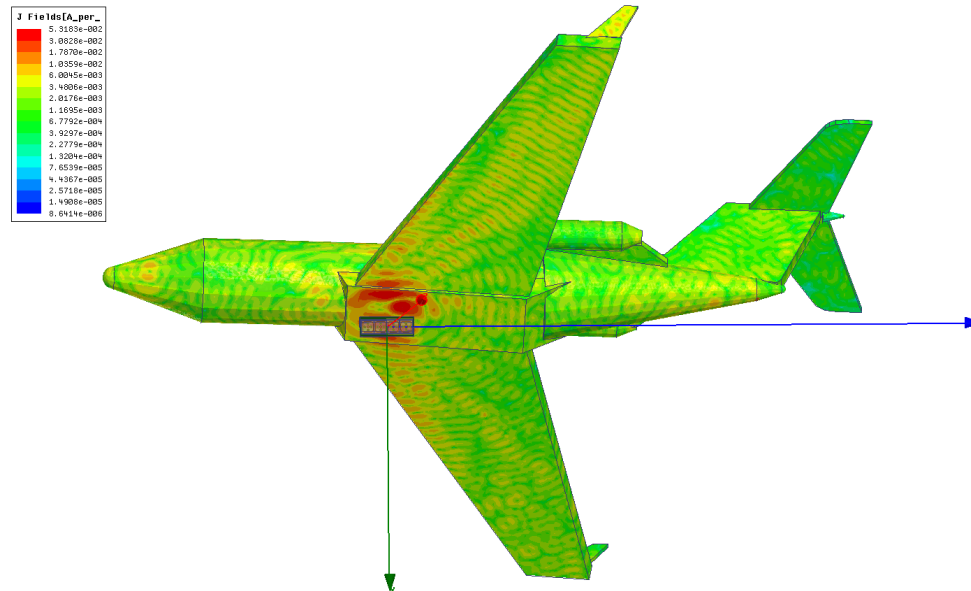
UAVSAR P-band Antenna



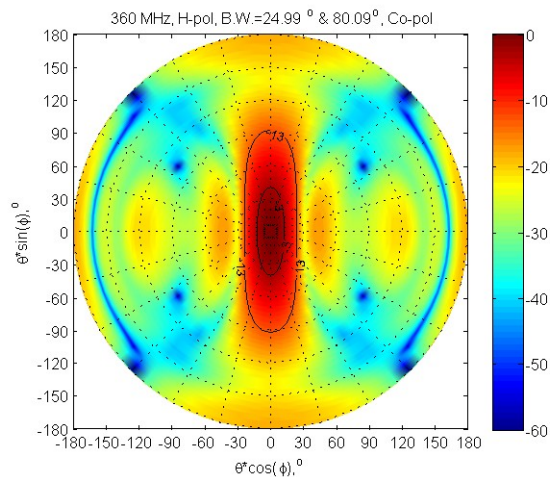
Broadband cavity-backed microstrip patch antenna

Antenna Characteristics	Values
Frequency	280 - 440 MHz
Polarization	V / H
3-dB Beamwidth	57° – 94° elev; 17° – 33° az
Beam boresight pointing accuracy	$\pm 5^\circ$ elev; $\pm 2^\circ$ az;
Size	179 cm * 64 cm

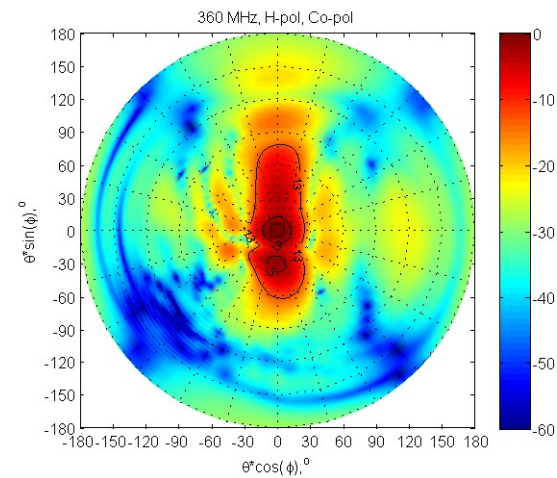




Simulated pattern without (*left*) and with (*right*) pod and aircraft



Look angle \gg



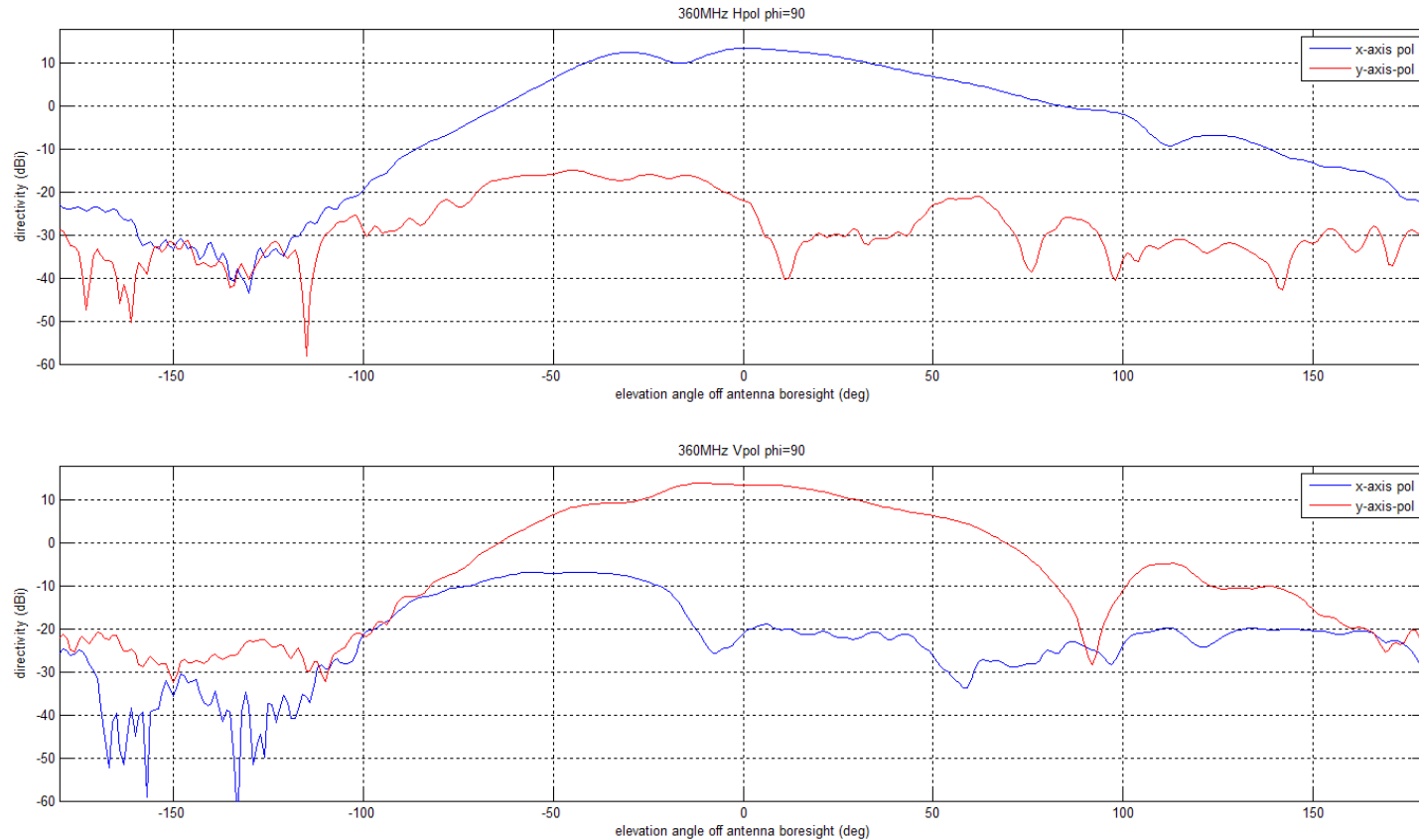


EM Simulation: Antenna + Pod + Aircraft



Elevation Cuts, H and V-pol:

- deviations (5dB) from antenna only pattern
- dependence (1dB) on details of aircraft structure representation.

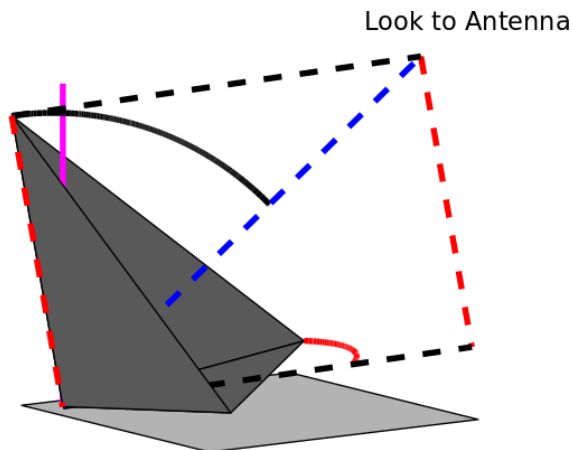




Antenna Gain Measurement Concept



- When the corner is in the antenna footprint, the received power is sampled from the Radar echoes at the peak closest to the predicted range offset determined from platform and corner positions.
- Estimate the antenna gain from the Radar equation using the known radiative propagation losses and corner gain: $P_r \propto P_t \frac{G_{ant} G_{corner}}{R^4}$
- Corner and antenna gains are dependents on components of the look vector from corner to antenna phase center.



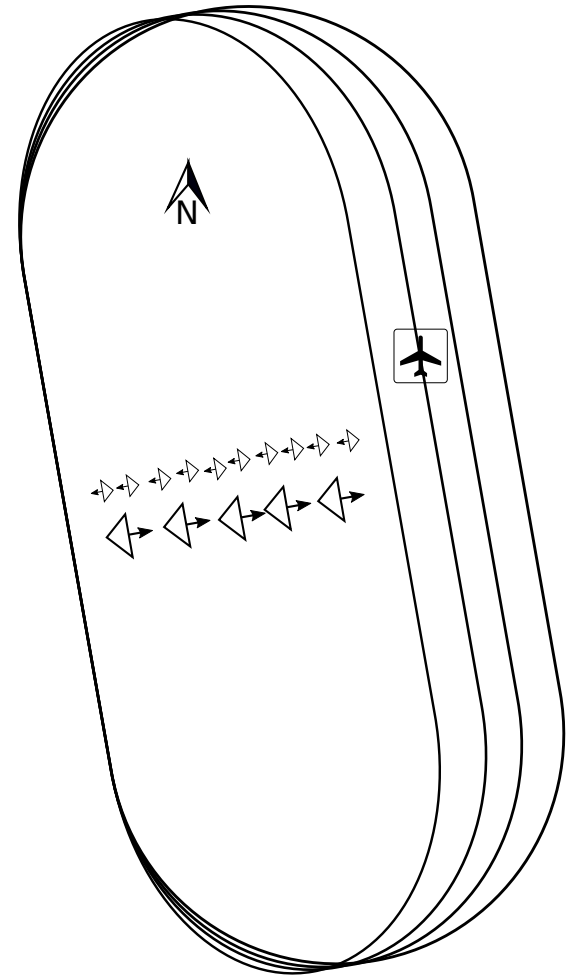
P_r	received power
P_t	transmitted power
G_{ant}	antenna gain
G_{corn}	corner gain
R	distance corner-antenna



Flight Configuration and Data Acquisition



- ♦ Rosamond dry lake bed corner reflector array.
- ♦ Left looking, North heading, sweeps large p-band corner reflectors.
- ♦ Flight lines configured such that the corner viewing geometry spans the range beamwidth.

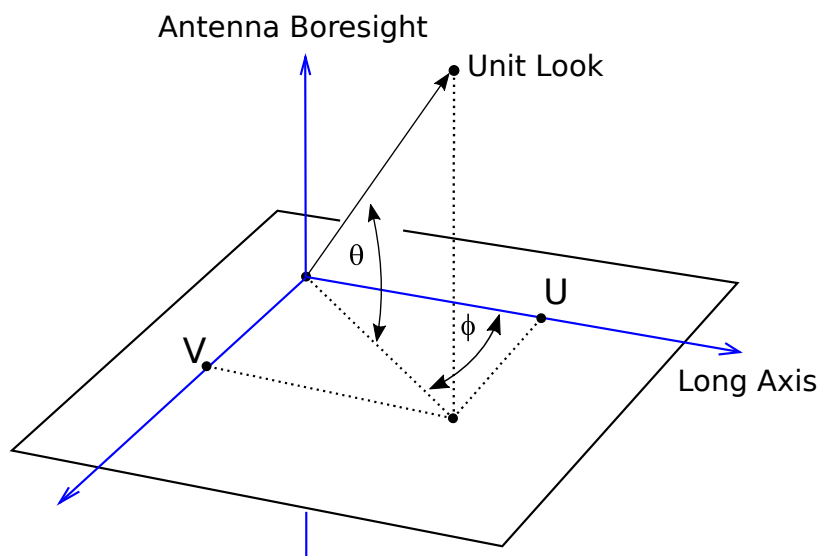




Antenna UV Corner Scans

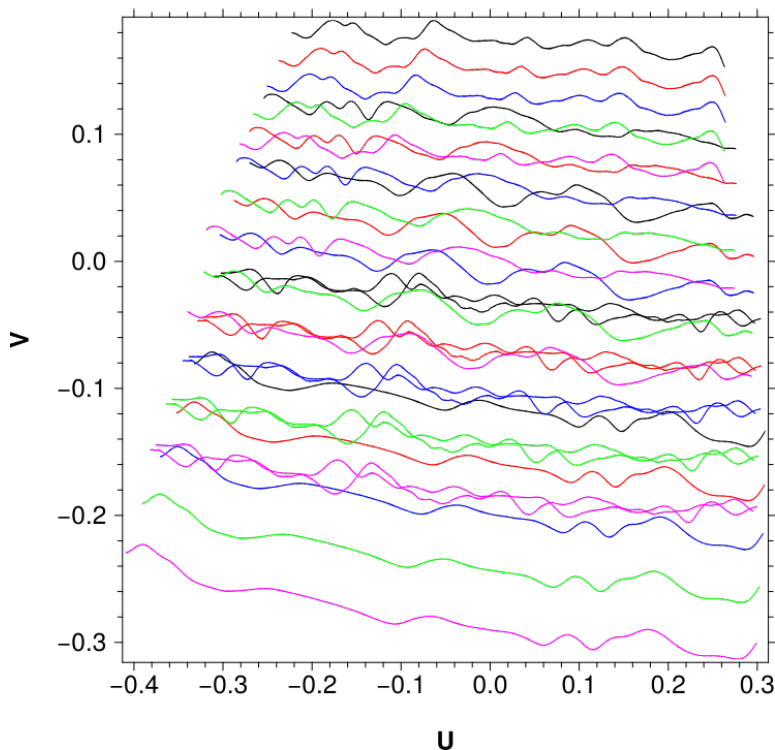


Tracing projections of the corner look vectors onto the antenna face.



$V \nearrow \Leftrightarrow \text{look angle} \nearrow$
 $U \nearrow \Leftrightarrow \text{look} \cdot \text{vel} \nearrow$

UV Pband Corner Trajectories: 1 Flight, 6 Lines, 5 Corners (color)

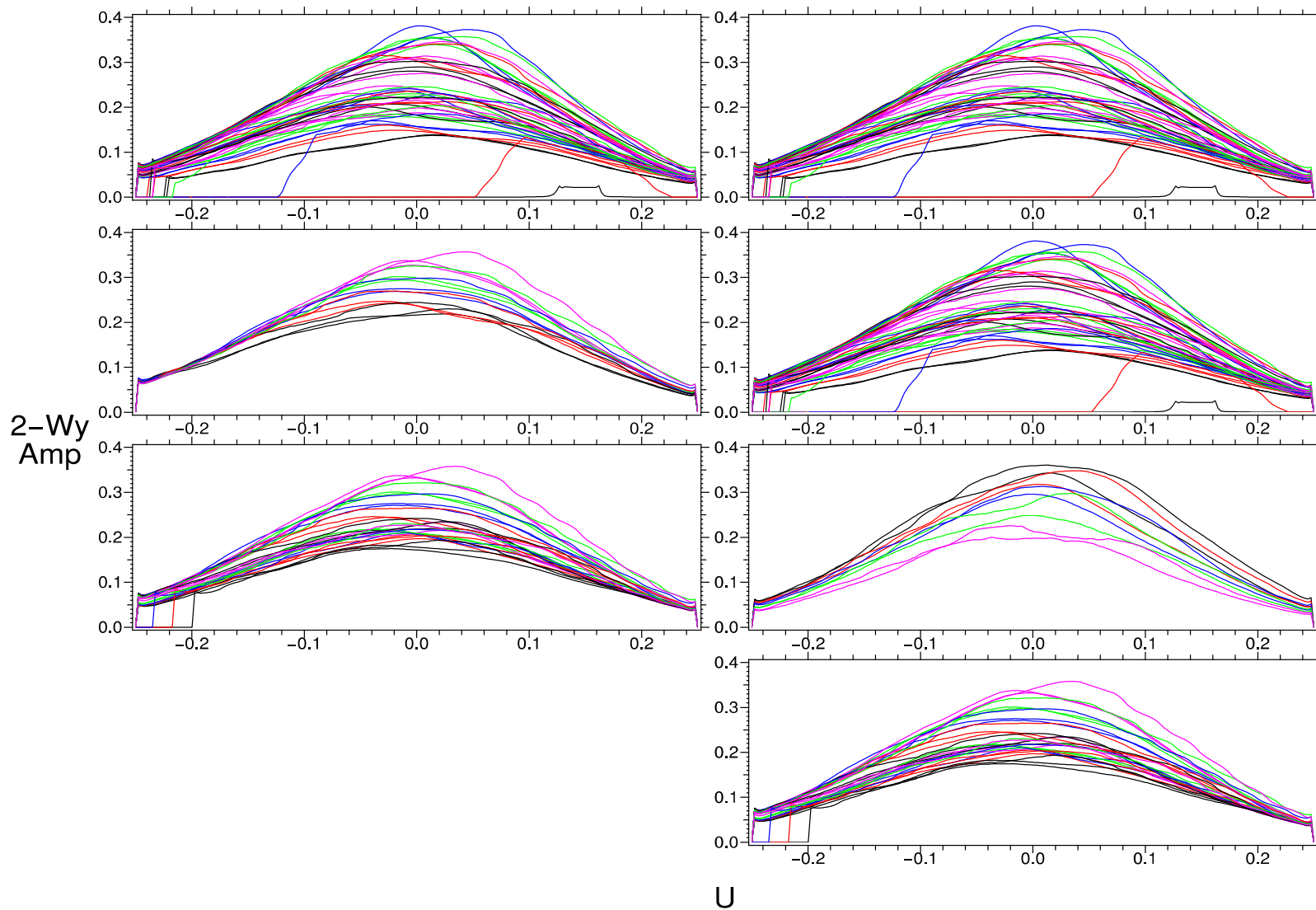




Antenna Gain Scans



P-band HH 350 Corner Repeats: 7-lines (1-per-fig) 5 corners (color)



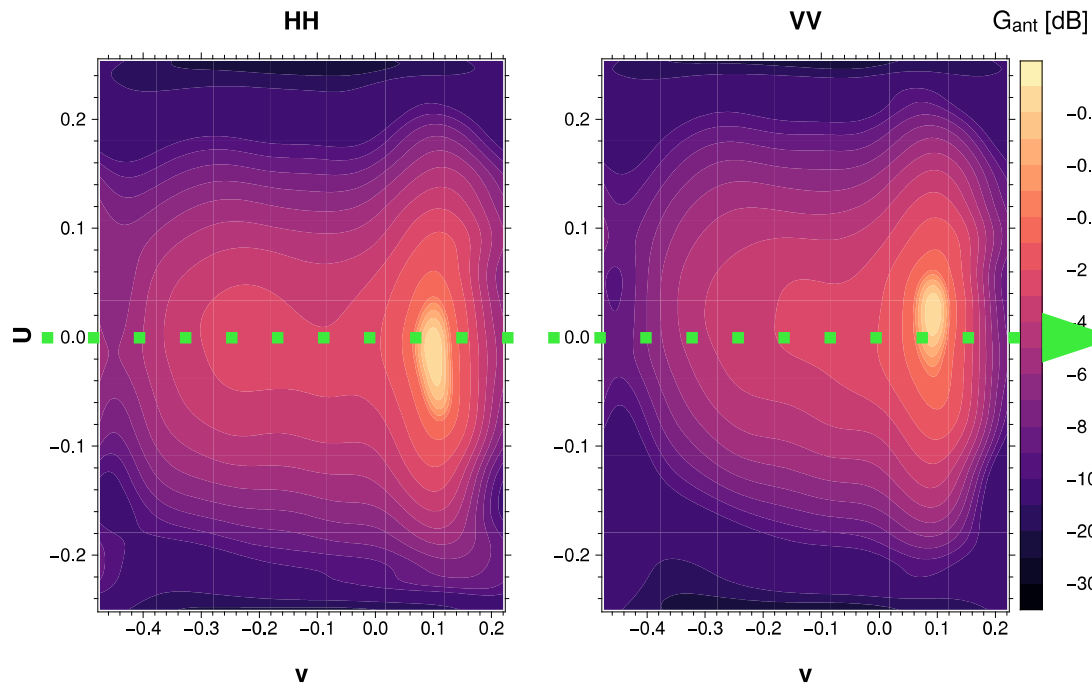


Measured Antenna Gain

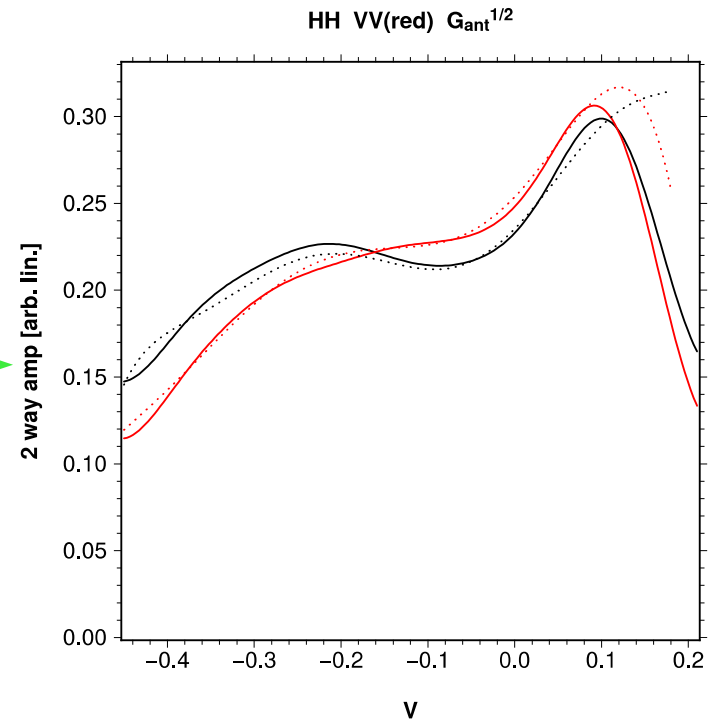


Estimated Antenna gains from 20 passes (7 different lines) over 5 corners.

$G_{ant}(U, V)$ gain distributions



$G_{ant}(U=0, V)$ gain cuts



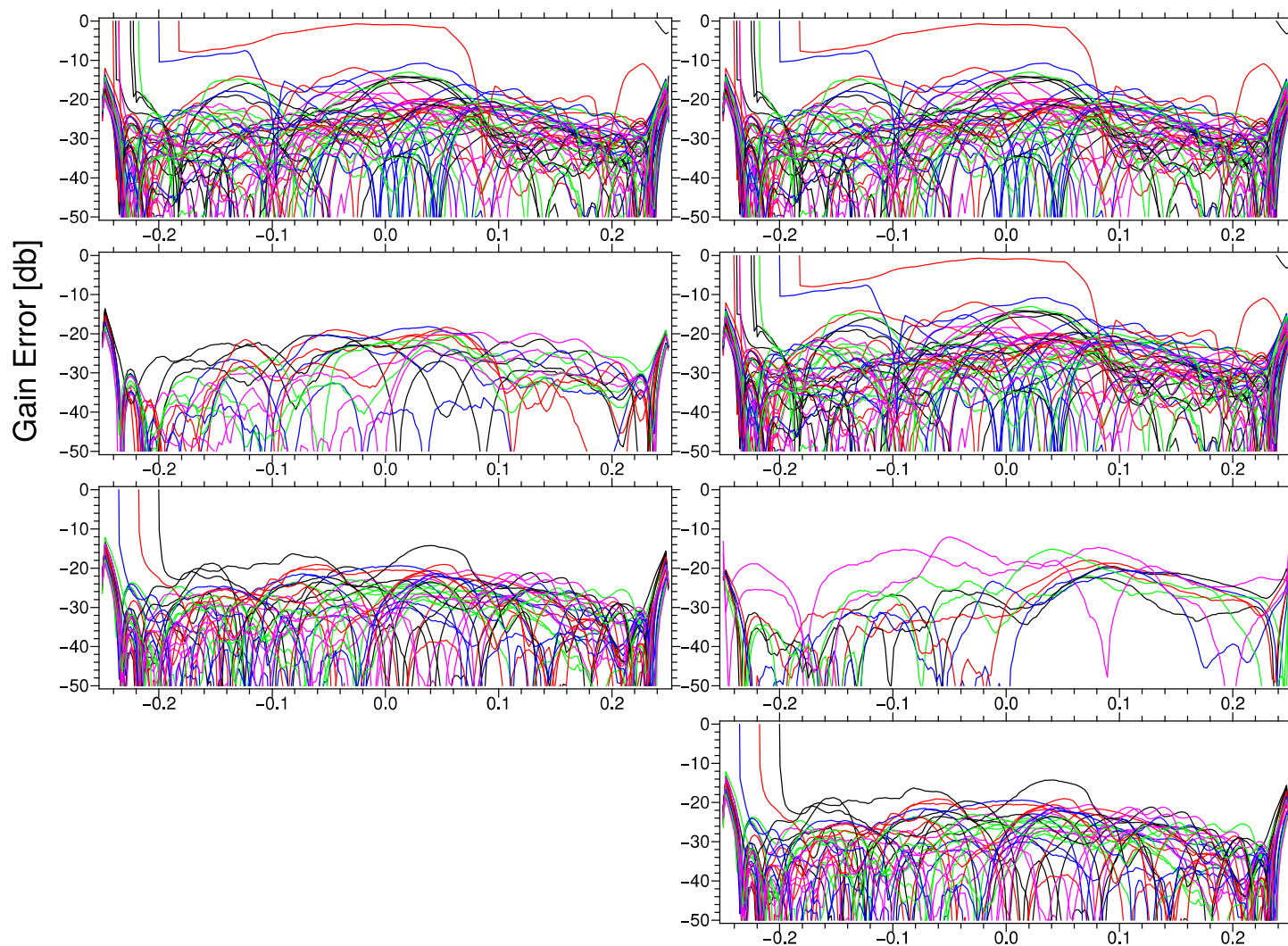
HH: black, VV:red
Solid: RC-data, Dotted: RCS2017



Antenna Gain Errors



P-band HH 350 Corner Repeats: 7-lines (1-per-fig) 5 corners (color)





Acknowledgments



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